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ABSTRACT

A study was conducted to investigate the effects of methylphenidate given in conjunction with reading remediation to children with pure reading disorders. A total of 66 children receiving motivated reading remediation were randomly assigned to either a placebo or a methylphenidate treatment group. A battery of reading, academic, and psychological tests was administered before, immediately after, two months after, and eight months after the treatment. When 22 basic reading skills were measured immediately after treatment, a significant advantage for the drug-treated group was found only on the reading of initial consonants; and a trend in favor of the methylphenidate group was found on spelling and comprehension tests. Performance on several of the psychological tests was significantly improved by methylphenidate. Posttests two and eight months after treatment revealed no significant differences in basic reading skills between the two groups, and no long term effects of methylphenidate on reading achievement and academic tasks. The failure to find long term advantages for the methylphenidate treatment, although drug effects had been obtained during treatment, suggested that stimulants may not enhance learning or the acquisition of skills, but may improve performance or the ability to apply mastered skills. (RL)

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Children with Reading Disorders:

II. Effects of Methylphenidate in Combination with Reading Remediation

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The acquisition of reading skills may be conceptualized as influenced by two broad classes of processes: intrinsic, and extrinsic, to the child. These are not completely independent of each other; they are reciprocally influential, but it is helpful to distinguish between them for purposes of clarifying the rationale for various treatment tactics in children where the acquisition of reading is impaired.

Intrinsic factors include the child's psychological deficits, which, for example, may consist of impaired perceptual organization, memory deficits (affecting recognition and recall), impaired language ability (which may be manifested in various ways), difficulty in maintaining focused attention, easy distractibility, etc.

Extrinsic factors involve environmental phenomena and encompass external opportunities as well as factors which shape the child's motivational set toward reading.

Reading is a chain of sub-goals in which success at each stage is necessary for success at subsequent stages. There is internal monitoring in the form of a developing narrative comprehension, and each sentence should add a new view of the subject matter. If comprehension does not develop, the reader knows that he is doing a bad job, and consequently experiences an increasing lack of satisfaction and an aversion to the task, with a growing impulse to leave the field. This related sense of failure is then confirmed by the social consequences. Therefore, among children with reading lags, even those who come from settings where external deprivation is not relevant, motivational factors may still be crucial in preventing benefit from experiences with reading.

Among the so-called intrinsic defects in children with reading disorders, language disorders of various sorts have been documented (Vellutino, 1978). Impaired attentional processes also have been invoked as leading to poor reading. Though definitional problems pervade the research literature on the characteristics of attention deficits in children with learning disabilities, a small number of investigators have restricted their samples to poor or retarded readers and have found that, compared to normal children, children with reading disorders are more vulnerable to the dis-

ruptive influence of interfering, distracting stimuli (Atkinson and Seunath, 1973; Dykman et al., 1971; Samuels, 1967; Santostefano et al., 1965). These findings have been interpreted as evidence in support of the attention-deficit hypothesis. Consequently, in children with an attentive defect, their measured reading disability is the interactive outcome of their attention defect, their sense of failure, their habit of non-perseverance, and their actual stage of development in cognitive skills and information. Dykman et al (1979) have presented the theory that non-hyperactive learning disabled children suffer from a defect in selective attention which prevents them from using flexible problem solving tactics. (Hyperactive children, in contrast, are believed to have a dysfunction in vigilance, or in sustaining attention.) However, this elegant model of differential attentional defects in two clinical groups was not supported in an experiment designed to test the model (Dykman et al., 1979).

An optimal treatment program would combine remediation of three interrelated deficits: motivational, attentional, and skill or knowledge development.

There is clinical evidence suggesting that rewarding, and thereby motivating, children who are receiving reading remediation significantly improves their progress. There has been, so far, very limited empirical investigation of the impact of improved attention on the acquisition of reading skills in children with reading disorders. It is generally agreed that psychostimulants, such as dextroamphetamine, methylphenidate, and magnesium pemoline, enhance performance on cognitive tests because of their positive effect on attention. As a matter of fact, the very first therapeutic use of stimulants in children was for the express purpose of improving cognitive performance (Bradley, 1937).

The issue whether stimulants are effective in altering children's learning deficits has been, and continues to be, the subject of much controversy (Dykman, 1980). Several reviews have appeared, all coming to the conclusion that stimulants have not been shown to induce significant improvement in children's academic performance (Aman, 1978; 1980). However, the bulk of the studies quoted selected children treated with

stimulant treatment because of behavioral problems and not because of learning disabilities. The failure to find drug-induced academic improvement in children with conduct problems does not compromise the clinical usefulness of this treatment for behavioral control, but merely restricts the range of therapeutic claims.

The same is not true of drug treatment of children with learning disorders who have no behavior problems. In such children, the failure to find drug-related effects on academic tasks would suggest that, even with improved attention, the acquisition of academic skills is not enhanced, thus yielding no basis whatever for using the drug.

A recent study by Aman and Werry (1981) addressed the issue of stimulant effects in 15 children with severe reading lags. No behavioral exclusionary criteria were used, and the clinical characteristics of the sample were not specified. Children received methylphenidate, diazepam and a placebo in a cross-over design, each drug condition lasting a total of six days. No significant drug effects on reading achievement were found in this study. It would be most surprising if a six day treatment period would suffice for changes to occur in level of reading, given the complexities of the task. The authors report that ethical considerations prevented longer drug trials. We believe that exposing children to experimental drug treatment, no matter how brief, raises even graver ethical questions when the probability of gaining knowledge is nil. Longer trials provide results which, even if negative, can influence clinical practice meaningfully. Furthermore, cross-over designs are especially inappropriate to the study of change in academic performance, since it is impossible to return to baseline levels given the incremental nature of the dependent measure (reading level) which occurs even if treatment is not effective. Fortunately, time alone modifies children's cognitive abilities. It may be argued that a 20-day period does not provide much chance for maturational changes; but this methodological issue is pinpointed since some erroneously provide the cross-over design as exemplar for the study of drug effects of academic functioning (Barkley and Cunningham, 1978).

In a 12-week study, Gittelman-Klein and Klein (1976) compared methylphenidate with a placebo in sixty-one children of average intelligence who had significant reading lags and no behavior problems. Methylphenidate was found to improve performance on many psychometric tests, but did not affect performance on standardized reading tests. The pattern of results indicated that performance on tasks which require speed of mental processing was improved by the drug, whereas performance on untimed, complex verbal tasks was not.

In a further report (Gittelman, 1980), none of the patient characteristics investigated predicted drug effect, as defined by significant improvement in reading performance. Thus, the presence of neurological signs, abonormal EEG's, and poor fine visual-motor development were not associated with a positive methylphenidate effect on reading performance in children with pure reading disorders.

The results of Gittelman-Klein and Klein (1976) might be interpreted to indicate that attention and learning capacity had been enhanced by methylphenidate (since several cognitive measures showed a significant drug effect), but that, in the absence of concurrent special remedial efforts, the children were unable to profit from their better attentional capacity. Thus, though more attentive, children with reading disorders might not gain in reading proficiency because of negative attitudes toward school, a sense of demoralization concerning their likelihood of succeeding, and the absence of appropriate opportunities to acquire reading skills. The normal classroom cannot be construed as satisfactory for enabling children with reading disorders whose attention has been improved with stimulant drugs, since the level of instruction is too far beyond the children's capacity and they lack the resources to catch up spontaneously, in spite of enhanced ability to concentrate.

Given this conjecture regarding stimulant effect on children with reading disorders, the best treatment would be a combination of specific reading instruction with a stimulant. A related study was conducted by Conrad et al (1971) in 68 children selected because of hyperactivity, rather than learning problems, who received one of four treatments: 1) dextroamphetamine; 2) placebo; 3) dextroamphetamine with

tutoring; 4) placebo with tutoring; all for a total of 40 sessions over a 20-week period. However, the results of the study are uninterpretable since a very large proportion of the children did not comply with their prescribed regimen.

The results obtained by Gittelman-Klein and Klein in the previous study of methylphenidate prompted the investigation of the hypothesis that methylphenidate in combination with a program of reading instruction would be superior to reading remediation alone in children with reading disorders uncomplicated by other psychiatric difficulties.

This study was part of a larger investigation in which three groups were studied: one group received reading remediation with a placebo; a second received academic tutoring and a placebo (without reading instruction); and a third group received reading remediation and methylphenidate.

The overall study was concerned with two central issues: whether reading remediation ameliorates reading performance in the short and long run; and whether methylphenidate in combination with reading remediation facilitates the acquisition of reading skills in children with reading disorders.

The contrast between the first two groups, which demonstrated the specific efficacy of reading remediation, is reported by Gittelman and Feingold. This report presents the data that address the second question, concerning the effect of methylphenidate treatment in children receiving reading remediation.

Methods

Subjects

Only children referred by teachers because of poor academic performance were included, provided they were not judged to have current behavior disorders. Ages spanned 7 through 12, and children had to be rated below the mean of 1.5 (out of a possible maximum of 3.0) on the Hyperactivity factor of the Conners Teacher Rating Scale.

A number of other criteria, inclusionary and exclusionary, were applied as described by Gittelman and Feingold.

Experimental Treatments

Two treatments were compared: motivated reading remediation with placebo, and motivated reading remediation with methylphenidate.

Motivated Reading Remediation. All children in this study received reading remediation which emphasized the teaching of phonic decoding and encoding skills.

The reading program was coupled by systematic reinforcement, so that the child was continuously rewarded for his participation. Tutoring was done individually, three times a week, for 18 weeks (for further details, see the paper by Gittelman and Feingold).

In addition, children were randomly assigned to either placebo or methylphenidate, and treated in double-blind fashion.

Methylphenidate Treatment. To have the medication condition parallel that of the previous study (Gittelman-Klein and Klein, 1976), similar prescriptive guidelines were followed. Within a four week period, children were to receive 60 mg/d of medication, contingent upon the absence of side effects; if no difficulties ensued, children were maintained on this dose for the balance of the study. Pills were prescribed to be taken in the morning and at noon. Drug condition was double-blind. Children were seen by a psychiatrist weekly for the first four weeks, and monthly or more thereafter. Medication was withdrawn after the 18 week treatment period.

Assessments

All academic and behavioral assessments were identical to those described in the paper reporting the effects of reading remediation (Gittelman and Feingold). These measures, briefly outlined, included: measures of basic reading skills; a test of word recognition, the Wide Range Achievement Test (WRAT); a test of paragraph reading, the Gray Oral Reading Test (Gray Oral); a test containing phonetic English only (Daniels and Diack); a paper and pencil achievement test which was administered individually (the Stanford Achievement Test); psychometric tests which included a continuous performance task, a paired-associate test, and the Visual-sequential memory test of the Illinois Test of Psycholinguistic Abilities; the Raven's Progressive Matrices: the Children's Em-

of Psycholinguistic Abilities; the Raven's Progressive Matrices; the Children's Embedded Figures Tests; the Purdue Pegboard; Porteus Mazes; a test of visual-motor coordination; and the Draw-A-Person Test.

Ratings of the child's behavior were made by the teacher on the Conners Teacher Rating Scale (Conners, 1969) and on the Behavior Rating Scale (Gittelman and Feingold), and by the parent on the Conners Parent Questionnaire (Conners, 1970) and Home Hyperactivity Scale (Werry and Sprague, 1970). The social worker who interviewed the mother also completed the Behavior Rating Scale.

The ratings were performed before and at the end of the 18-week treatment. In addition, global ratings of improvement were filled out by the teacher and mother upon termination of treatment.

All children were recalled for evaluation twice: the first time, two months after the cessation of treatment; the second time, six months later--after a total of eight months had elapsed since treatment termination. Children had all been off their respective medication since the end of the reading remediation.

Data Analyses

The scores of the two treatment groups obtained before treatment were compared by means of analysis of variance to assess whether the two groups differed before the study.

Post-treatment scores were subjected to analyses of covariance, wherein the pre-treatment scores were the covariate, so that the post-treatment values presented are all free of influence of pre-treatment values.

Global improvement ratings by teachers and mothers were dichotomized, and χ^2 tests performed.

All tests of probability presented are two-tailed, in spite of the directional prediction made before the study, to ensure the detection of deleterious effects with methylphenidate, should any occur, and to present conservative tests of treatment differences.

Results

Subjects

A total of 66 children entered the study, 33 of whom were randomly assigned to motivated reading remediation and placebo, 33 to motivated reading remediation and methylphenidate. (The two groups will be referred to as the placebo and the methylphenidate group, respectively, in the rest of the paper; however, it should be remembered that all children received similar remedial reading.)

Three children dropped out of the placebo group (see Gittelman and Feingold), and two from the methylphenidate group, before the end of the study. Of the latter group, one 12-year-old youngster refused to continue after three weeks because of extreme embarrassment at his very limited reading ability (below second grade on all measures); the other child was withdrawn by the mother after a few sessions because of her discomfort about medication. In neither of the children was the presence of side effects a contributing factor to withdrawal.

The demographic characteristics of the sample are given in Table 1. The mean age was 10 years old; boys were over-represented in a 2:1 ratio; most (82%) were white; social class tended to be lower middle class. This group of children is well representative of the lower middle working class population of the clinic's suburban location.

The children's full scale IQ's ranged from 80 to 115, with a mean of 97.24 (see Table 11 for IQ characteristics of both groups).

The results of the rating scales completed by teachers and parents confirm the fact that the children were not perceived as disruptive or symptomatic. Thus, on the Teacher Rating Scale, the factors of Conduct Problems, Anxiety, and Hyperactivity were all below 1.0 (score range, 0 - 3), as indicated in Table 2. However, the children were more deviant on the Inattention factor, confirming the notion that attentional problems, as viewed by teachers, may occur among children with reading disorders even when the presence of behavioral disturbance is ruled out,

Teachers also rated the children's behavior as unremarkable on the Behavior Rating Scale (Table 3). The eight factor scores of the Parent Questionnaire were very low as well; all rated below 1.0 (score range, 0 - 3) (see Table 4).

The average class placement for the children was at the 5th grade level, yet their reading scores were below the second grade on the Gray Oral Reading Test (Gray Oral) and below the third grade on the Wide Range Achievement Test (WRAT) (see Table 7). On the Stanford Achievement Test as well, the children performed very much below grade level (between the 2nd and 4th grades) (see Table 9).

Scores obtained on other academic subjects (mathematics, social studies, and science) of the Stanford Achievement Test showed that the children were over one year below grade level in these subjects (see Table 10).

Calculating the children's reading decrement, based on their mental age derived from verbal IQ scores, reading retardation was found to range from one year to almost seven years on the Gray Oral Reading Test. Of the 61 children in the study, 53 (87%) had reading lags at least two years below their mental age.

Group Differences before Treatment

Before treatment, none of the mean group values significantly differentiated the two groups, indicating successful randomization.

Methylphenidate Dosage

At the end of the 18-week period, the children were receiving an average of 44.19 mg/d of methylphenidate. The range of daily dosage was from 10 to 60 mg. The children's weight ranged from 24.5 kg to 78.8 kg, and the mean daily dose was 1.19 mg/kg at the end of treatment (range, .41 to 2.23 mg/kg). Since dosage was increased only if side effects were not problematic and when there was no other factor affecting medication increases, the children did not experience clinically significant side effects.

To maximize cooperation with prescription, parents had to return unused pills at each visit. These were counted and the results communicated to the treating doctor so that discrepancies could be reviewed with the parent. Cooperation with prescribed medication was not an obvious problem in any of the children.

Methylphenidate Effects on Basic Reading Skills

The effects of methylphenidate on the 22 measures of basic reading skills are presented in Tables 5 and 6. A significant advantage for the drug-treated group was obtained on one of these measures (on the reading of Initial Consonants, $p < .03$). A trend in favor of the methylphenidate group occurred on two other tests: Spelling ($p < .06$) and Comprehension ($p < .09$).

Methylphenidate Effects on Reading Achievement

The scores on the WRAT and Gray Oral at the end of treatment were not significantly different between the two groups. These results are presented in Table 7.

On the Daniels-Diack phonetic reading test, significantly superior performance for the methylphenidate-treated children as compared to the placebo group was found on one of the reading tasks (Polysyllabic-Phonically Simple words, $p < .04$). Trends were found on the Reading Age ($p < .10$) and on the reading of Graded Phonically Complex Words ($p < .06$) in favor of the methylphenidate-treated children (Table 8).

As indicated in Table 9, of the four reading tests of the Stanford Achievement Tests, the Language subtest showed a significant advantage for the methylphenidate group ($p < .02$). This test includes a variety of skills: punctuation, capitalization, sentence structure, and comprehension.

Methylphenidate Effects on Academic Tasks Other Than Reading

The scores obtained after treatment on the arithmetic and spelling tests of the WRAT, as well as the Mathematics, Social Studies, and Science subtests of the Stanford Achievement Test, are presented in Table 10.

The WRAT grade levels of arithmetic and spelling did not differ between the placebo and methylphenidate groups.

On the Stanford Achievement Test, the children who were on methylphenidate obtained significantly higher scores than the placebo-treated children on three of the four math measures: Math Computation ($p < .04$), Math Application ($p < .005$), and Total Math ($p < .0003$).

In addition, the drug-treated group performed significantly better than the placebo group on the Social Studies subtest of the Stanford Achievement Test ($p < .005$).

Methylphenidate Effects on Psychological Tests

Performance on several of the psychological tests was significantly improved by methylphenidate. These data are presented in Tables 11 and 12.

Methylphenidate led to improved scores on the Performance IQ of the WISC-R. The mean IQ's, after treatment, of the methylphenidate and placebo groups were 113.08 and 107.58, respectively ($p < .02$). The drug-induced advantage on the Performance IQ is reflected in significant group differences on the Full Scale IQ (FISQ) in favor of the drug-treated children ($p < .02$), whose mean FSIQ was 106.45 compared to 101.73 in the placebo group (Table 11).

Table 12 presents treatment differences on the other psychological measures. The drug-treated group had significantly fewer errors of commission on the Continuous Performance Task ($p < .04$). The mental age on the Visual Sequential Memory test was significantly superior in the methylphenidate-treated children; the advantage of this group over the placebo group was the equivalent of 10 months ($p < .04$). Nonverbal reasoning, as reflected by scores on the Raven's Matrices, was also improved by methylphenidate ($p < .02$).

The mean latency on the Matching Familiar Figures Test, which is an indication of how long children examined the figures before giving a response, was increased by methylphenidate ($p < .02$). However, the error rate was not significantly affected by the medication.

The number of mazes accurately completed, as reflected in the IQ scores, was significantly increased by the drug ($p < .005$).

Other measures, such as the Continuous Performance test (rate of errors of omission) and the Purdue Peg Board (left hand performance and assembly subtests), showed trends favoring the methylphenidate-treated children ($.05 < p < .10$).

Global Ratings of Academic Improvement

On overall estimates of improvement, the teachers did not rate the two treatment

groups significantly differently. Thus, of the methylphenidate group, 28% were rated improved in reading; of the placebo-treated group, 17% (χ^2 = .65, n.s.). The same pattern of results was obtained on overall ratings in arithmetic (χ^2 = .34, n.s.), and on overall academic achievement (χ^2 = .07).

The mothers also failed to distinguish the two treatments on their overall evaluations (χ^2 = .07), but they reported very high rates of improvement--over 60% in both groups.

Long-Term Effects of Methylphenidate Treatment

The long-term effects of the four months of treatment with methylphenidate were examined two and eight months after treatment termination. None of the children received medication or tutoring during these intervals.

Of the 30 children on placebo who completed the 18-week treatment study, one was unavailable for testing at the two months follow-up. For the second reevaluation, eight months after treatment cessation, three were not evaluated (see Gittelman and Feingold for the specific reasons for dropout).

All the children in the methylphenidate group were evaluated at the two month follow-up. Two could not be seen at the eight month point because of parental refusal, leaving 29 children seen at the second reevaluation.

Long-Term Effects of Methylphenidate on Basic Reading Skills. The follow-up treatment scores on basic reading skills are given in Tables 13 and 14. As may be noted, no significant differences were obtained between the groups two and eight months after treatment.

Long-Term Effects of Methylphenidate on Reading Achievement. The two treatment groups obtained indistinguishable scores at both follow-up points on the word recognition test of the WRAT and on the contextual oral reading test (Gray Oral Reading Test) (Table 15). A trend in favor of the children who had received methylphenidate was found on the Reading Comprehension subtest of the Stanford Achievement ($p < .08$).

On the Daniels and Diack phonetic reading test, a significant difference on, the reading of Reversible Words was found ($p < .05$), which indicates better perfor-

mance in the previously placebo-treated children two months after treatment (Table 16). This difference was not observed at the eight-month retest. None of the other measures of the Daniels and Diack test was found to differ significantly between the groups at follow-up.

The Stanford Achievement reading tests did not differentiate the two treatments significantly at either follow-up point (Table 17).

Long-Term Effects of Methylphenidate on Academic Tasks Other Than Reading. The results obtained at follow-up on the WRAT Spelling and Arithmetic tests, and on the Stanford Achievement tests of Mathematics, Social Studies, and Science, are presented in Table 18. None of the measures significantly differentiated the two groups after two and eight months of treatment.

Discussion

In our previous three month study of children with pure reading disorders who received methylphenidate but no special remediation, clear drug effects were obtained on cognitive tasks, but not on achievement scores (Gittelman-Klein and Klein, 1976). In that study, the only achievement tests used were the WRAT and the Gray Oral. Had the present study been limited to the same measures, identical results would have been obtained. This study, which investigated the effects of methylphenidate given in conjunction with reading remediation, replicated the earlier findings of significant positive drug effects on psychological test scores, but no effect on the achievement tests previously used.

A somewhat different picture was obtained from other achievement measures. One of the subtests of the Daniels and Diack test, Polysyllabic Words, was significantly improved with methylphenidate treatment. Likewise, the Language subtest of the Stanford Achievement test showed a significant advantage for the methylphenidate-treated children. Moreover, some trends in favor of the drug-treated group were found on reading measures. The fact that the reading improvement was not observed in more instances suggests that the effect of methylphenidate on reading is not a strong one. Indeed, the significant difference in reading on the Daniels and Diack test is un-

impressive. The drug-induced improvement on the language test of the Stanford Achievement is more substantial and seems clearly meaningful: the children on medication had a seven month advantage on this measure. However, though in some cases significant, these results are not interpreted as indicating a meaningful advantage in reading ability for tutored children who received methylphenidate over those treated with a placebo.

As in our previous study, we failed to find a drug effect on the WRAT test of arithmetic. However, a striking difference is the consistent finding of marked drug-induced improvement on the tests of mathematics and social studies of the Stanford Achievement tests. In some cases, this improvement was of a magnitude indicating functionally meaningful gains. For example, on the Total Math scores, there was an eight-tenths of a year difference betwen the treatment groups, and over half a year in social studies. On some mathematics measures, performance on methylphenidate reached grade appropriate levels. These differences occurred on measures which tapped skills that were not included in the training program. Thus, reading, which was taught, was not enhanced to a clinically important degree by methylphenidate, whereas mathematics, which was not part of the remedial teaching, was positively affected. As we note in another paper (Gittelman and Feingold), the WRAT does not sample adequately the child's competence at each level of difficulty, and, therefore, may limit the detection of treatment effects.

From our results, the inference may be drawn that, among children who receive individual reading assistance consisting of phonetic remediation, the addition of methylphenidate in the doses used induces significant advantages in academic tasks other than reading. Since the academic measures found sensitive to drug effect in this study have never been included in studies where children with reading disorders have received methylphenidate alone, it is not possible to interpret the drug effects conclusively. It is conceivable that methylphenidate alone, without any concomitant factors, would also induce changes on paper and pencil tests of mathe-

matics and social science.

It is conceivable that, with longer treatment periods, differences between the two groups might become more marked and apparent on more reading tests as well. Of course, it is also possible that tolerance to the drug's effects would occur with more extended treatment. However, since tolerance was not found over a minimum of four months, it seems unlikely that it would occur over longer periods.

This study was based on the observation that methylphenidate-induced attentional enhancement did not lead automatically to superior performance on achievement tests, since it could not compensate for the previous lack in skill development. It was argued that stimulants prepared the children for better learning, but that this could occur only with the addition of special educational efforts. This expectation was not borne out by the results of our study. Even if methylphenidate is administered in combination with remediation, no clear, consistent improvement in reading performance can be expected. This finding is felt to be a fair representation of the average results. However, it is possible that some children, yet to be identified, may be particularly responsive to the combined therapy--remediation and methylphenidate. We tend to believe this may be the case because of observations from the tutoring staff that some of the children on placebo (clearly not all, and not even the majority) could not be engaged adequately in the teaching program due to their difficulties in maintaining focus.

In view of our findings of some effect on reading, it appears worthwhile to investigate whether there is a subgroup of children with reading disorders for whom the addition of methylphenidate to an ongoing tutoring program makes a significant difference. However, in the absence of such information, it is not justified to suggest that stimulants be used to alter the academic progress of children with pure learning disorders.

The effects of methylphenidate on math performance need to be examined further to assess whether they occurred mostly in children with poor math skills, or whether

they were independent of the children's competence in math before treatment.

The failure to find long-term advantages for the methylphenidate-treated children, when drug effects had been obtained during treatment, suggests that stimulants may not enhance learning, or the acquisition of skills. Rather, they may be viewed as improving performance, or the ability to apply mastered skills. It is not possible to establish mechanisms of action from studies not designed to generate such data. However, it seems unlikely that learned skills would dissipate with drug withdrawal. Yet, this is what some investigators have suggested by claiming a state-dependent phenomenon with regard to the acquisition of skills in stimulant-treated children (Swanson and Kinsbourne, 1976). Douglas (1980) notes that the use of stimulants in conjunction with a training program is problematic, due to the potential danger of putting children at a disadvantage after termination of treatment. Our results do not support this expectation.

Only one measure, out of more than seventy, indicated a significant disadvantage for the methylphenidate group compared with the placebo group after drug withdrawal: reading of Reversible Words ($p < .05$) (see Table 16). Another measure showed a trend ($p < .08$) in favor of the drug-treated children (Reading Comprehension, see Table 17). These differences are well within the range of expected chance findings. Furthermore, a perusal of the children's scores at follow-up does not indicate a pattern of worse performance (even if not significant) for previously methylphenidate-treated children versus those who received a placebo. Therefore, our findings are not consistent with the state-dependent hypothesis of stimulant effect.

This issue has minimal clinical relevance to the treatment of children with pure reading disorders, since we find little basis for the use of stimulants in these cases. However, the same is not true of hyperactive children to whom stimulants are administered for behavioral control. Were this practice to put hyperactive children at risk for eventual cognitive disadvantage, it would pose serious limitations on the usefulness of the treatment, if not preclude it in many or most cases. The fact that no evidence for state-dependent learning was obtained among non-hyperactive

children does not establish that it does not exist among hyperactive children. Though the possibility is present, it seems improbable since the stimulants have not been found to have diagnostically-related specificity of effect on cognitive measures (Dykman, Ackerman, and McCray; Weingartner, et al., 1980; Rapoport, et al., 1978).

It could be argued that our training program was ineffective and failed to induce learning. If so, no decrement in performance would be discerned after drug withdrawal. Clearly, this was not the case. As we report in another paper (Gittelman and Feingold), significant effects of reading remediation were found on many measures of reading in the study which compared the group which received reading remediation and placebo with a control group. Therefore, an optimal opportunity existed for the detection of significant performance deterioration in children withdrawn from stimulants.

The lack of drug effect on tests of basic reading skills should be viewed with the understanding that the remedial tutoring led to great improvement on these measures (see Gittelman and Feingold), and that little room for further gains remained.

The same cannot be said, however, of the reading tests, which do not have a ceiling limitation performance (except for the Daniels and Diack, which does not test beyond fifth grade competency).

It is common for parents and teachers of methylphenidate-treated hyperactive children to report marked improvement in school performance. Yet, attempts to document these observations have not succeeded; and it is now generally believed that academic improvement is not associated with methylphenidate treatment. Are the changes reported by teachers and parents to be considered mirages? If we were to generalize from the results obtained in this study to hyperactive children, we would conjecture that school performance probably improves with methylphenidate, since children perform better on a variety of academic tasks, especially mathematics.

The clinical reports of better school work are therefore likely to reflect objective change. This improvement, however, does not affect all functions; it is not apparent on reading measures, which have been used almost exclusively to assess academic improvement.

The methylphenidate dosage used in this study was relatively high (mean daily dose of more than 40 mg/d). It was selected to be equivalent to the doses used in our previous study (Gittelman-Klein and Klein, 1976), since this investigation was designed as its extension. Sprague and Sleator (1977) have argued that low doses are optimal for inducing cognitive improvement. Our design does not allow a test of this view, but our results indicate that, even at relatively high doses, psychometric test performance is significantly improved by methylphenidate. High dosage certainly does not compromise learning; whether more drug effects would have been obtained with less medication cannot be addressed.

Table 1

Demographic Characteristics

Group Characteristic	Treatment Group: Reading Remediation (N = 30)	Treatment Group: Remediation & Methylphenidate (N = 31)	Total (N = 61)
Age (in months)			
Mean	120.5	122.3	121.41
s.d.	15.0	19.2	17.21
	Percent	Percent	Percent
Sex			
Boys	60	77	69
Girls	40	23	31
Race			
White	77	87	82
Black	23	13	18
SES			
I & II	13	9	11
III	30	29	30
IV	57	52	55
V	0	9	4
Religion			
Protestant	23	16	20
Catholic	37	52	44
Jewish	30	19	25
Other or None	10	13	11

Table 2

Pre-Treatment Mean Factor Scores[x]

Of the Teacher Rating Scale

Factor	Treatment Period	Treatment Group: Reading Remediation (N = 30) Mean	s.e.	Treatment Group: Remediation & Methylphenidate (N = 31) Mean	s.e.	ANOVA p^{++}
I Conduct Problems	Pre	.13	.10	.00	.07	n.s.
II Inattention	Pre	1.71	.16	1.69	.17	n.s.
III Anxiety	Pre	.60	.10	.65	.12	n.s.
IV Hyperactivity	Pre	.90	.10	.69	.12	n.s.
V Sociability[+]	Pre	-1.13	.00	-1.16	.02	n.s.

[x] score range, 0 - 3

[+] negative Item loadings

[++] two-tailed tests

Table 3

Pre-Treatment Mean Values of
Behavior Rating Scale completed by Teachers

Item	Treatment Period	Treatment Group: Reading Remediation Mean	Reading Remediation s.e.	Remediation & Methylphenidate Mean	Remediation & Methylphenidate s.e.	ANOVA p^{++}
1. Activity (-2 to +7)	Pre	1.73	.36	1.18	.48	n.s.
2. Distractibility (1-5)	Pre	2.86	.27	2.88	.28	n.s.
3. Frustration Tolerance (-1 to +5)	Pre	.57	.29	.56	.30	n.s.
4. Cooperation (1-5)	Pre	2.13	.23	2.12	.25	n.s.
5. Mood (1-6)	Pre	2.14	.42	2.38	.27	n.s.
6. Attitude Toward Work (-1 to +5)	Pre	2.47	.49	3.31	.35	n.s.
7. Interest in Tasks (1-5)	Pre	3.07	.30	3.13	.33	n.s.
8. Anxiety about Failure (-2 to +5)	Pre	1.87	.51	2.06	.50	n.s.
9. Attention Seeking Devices (1-5)	Pre	2.07	.27	1.82	.29	n.s.
10. Impulse Control (1-5)	Pre	2.10	.28	2.18	.33	n.s.
11. Initiation of Aggression (1-5)	Pre	.71	.27	.67	.25	n.s.
12. Joining Aggressive Activities (1-5)	Pre	2.20	.36	1.64	.28	n.s.
13. Popularity (1-5)	Pre	2.30	.40	2.25	.43	n.s.

++two-tailed tests

(Range of scores in parentheses)

Table 4

Pre-Treatment Mean Values
of Mothers' and Social Workers' Behavioral Ratings

Measure and Rater	Treatment Period	Treatment Group: Reading Remediation Mean	Reading Remediation s.e.	Remediation & Methylphenidate Mean	Remediation & Methylphenidate s.e.	ANOVA p^{++}
Home Hyperactivity Scale						
Mother	Pre	1.90	.11	2.05	.12	n.s.
Social Worker	Pre	1.81	.10	1.97	.13	n.s.
Parent Rating Scale (0 - 3)						
I Conduct	Pre	.51	.07	.55	.07	n.s.
II Anxiety	Pre	.60	.08	.69	.09	n.s.
III Impulsivity	Pre	.45	.12	.48	.12	n.s.
IV Immaturity	Pre	.85	.07	.77	.08	n.s.
V Psychosomatic	Pre	.26	.07	.27	.06	n.s.
VI Obsessional	Pre	.54	.14	.42	.11	n.s.
VII Antisocial	Pre	.66	.03	1.03	.34	n.s.
VIII Hyperactivity	Pre	.61	.06	.66	.06	n.s.

++ two-tailed tests

Table 5

Pre-Treatment* and Post-Treatment** Mean Values on

Pollack Auditory and Basic Reading Skills Tests

Test	Treatment Period	Treatment Group: Reading Remediation (N = 30) Mean	s.e.	Treatment Group: Remediation & Methylphenidate (N = 31) Mean	s.e.	ANCOVA t	p++
Auditory							
Phoneme Discrimination (% correct)	Pre	90.60	1.77	89.90	2.20		
	Post	99.53	.18	99.68	.17	.59	n.s.
Blend Score (% correct)	Pre	49.33	4.83	45.68	6.06		
	Post	95.82	1.11	96.52	1.09	.45	n.s.
Basic Reading Skills+							
Initial Consonants Oral	Pre	1.93	.40	1.35	.41		
	Post	.03	.06	.23	.06	2.31	.03
Initial Consonants Written	Pre	.90	.44	.52	.20		
	Post	.00	.00	.00	.00	.00	n.s.
Blending Separate	Pre	4.77	.43	5.29	.54		
	Post	.69	.16	.53	.15	.72	n.s.
Blending Blended	Pre	5.17	.40	5.29	.56		
	Post	.97	.16	.70	.15	1.25	n.s.
Rhyming Verbal	Pre	.93	.26	1.10	.25		
	Post	.07	.04	.01	.04	1.39	n.s.
Rhyming Written	Pre	1.40	.27	1.61	.28		
	Post	.14	.06	.06	.06	1.03	n.s.
Vowel Discrimination	Pre	1.80	.26	1.84	.28		
	Post	.53	.17	.58	.17	.17	n.s.
Final Consonants	Pre	1.47	.19	1.13	.21		
	Post	.22	.06	.08	.06	1.55	n.s.
Rule of Silent E	Pre	3.10	.36	3.61	.35		
	Post	1.08	.31	1.11	.30	.00	n.s.
Spelling	Pre	4.30	.45	4.61	.48		
	Post	1.50	.23	.90	.03	1.92	.06

(Table 5 continued)

Dictation	Pre	2.63	.36	3.23	.48		
	Post	.19	.07	.17	.07	.20	n.s.
Comprehension	Pre	1.97	.45	1.83	.52		
	Post	.61	.14	.28	.14	1.72	.10
Rosner Auditory Analysis[x]							
	Pre	-14.67	1.18	-15.84	1.22		
	Post	-8.57	1.99	-3.21	1.96	1.92	.06

* For the sake of brevity and readability, the specific t and p values for group comparisons before treatment are not presented since none was significant at the p = .05 level.

** All post-treatment means adjusted for pre-treatment values.

+ Number of errors

++ two-tailed tests

[x] Difference between child's score and norm for age (negative score indicates poor performance)

Table 6

Pre-Treatment* and Post-Treatment** Mean Values
on Monroe Auditory Discrimination and Roswell-Chall Auditory Blending
and Diagnostic Reading Tests

	Treatment Period	Treatment Group: Reading Remediation Mean	Reading Remediation s.e.	Remediation & Methylphenidate Mean	Remediation & Methylphenidate s.e.	ANCOVA t	ANCOVA p++
Monroe Auditory Discrimination+	Pre	.77	.19	.45	.72		
	Post	.19	.09	.11	.09	.63	n.s.
Roswell-Chall Auditory Blending×	Pre	27.07	.72	26.32	.97		
	Post	29.59	.12	29.69	.12	.45	n.s.
Roswell Chall Diagnostic Reading+							
Single Consonant Sounds	Pre	4.03	.70	3.65	.62		
	Post	.32	.11	.27	.11	.37	n.s.
Consonant Combination	Pre	3.93	.49	4.13	.57		
	Post	1.23	.23	.94	.23	.87	n.s.
Short Vowels	Pre	10.79	1.11	11.32	1.26		
	Post	.81	.24	1.01	.24	.58	n.s.
Rule of Silent E	Pre	3.90	.50	3.77	.59		
	Post	.91	.25	1.18	.25	.76	n.s.
Vowel Combination	Pre	6.37	.66	5.77	.65		
	Post	3.82	.43	4.04	.43	.36	n.s.
Syllabification	Pre	6.10	.25	5.94	.29		
	Post	7.52	1.28	5.44	1.26	.97	n.s.

* For the sake of brevity and readability, the specific t and p values for group comparisons before treatment are not presented since none was significant at the p .05 level.

** All post-treatment means adjusted for pre-treatment values.

+ Number of errors

++ two-tailed tests

× Number correct

Table 7

Pre-Treatment* and Post-Treatment** Mean Levels on

Gray Oral Reading (GOR) and Wide Range Achievement Tests (WRAT)

Reading Test	Treatment Period	Treatment Group: Reading Remediation (N = 30) Mean	s.e.	Remediation & Methylphenidate (N = 32) Mean	s.e.	ANCOVA: t	p++
GOR (Grade Level)	Pre	1.97	.09	1.87	.08		
	Post	2.73	.14	2.89	.14	.80	n.s.
WRAT (Standard Scores)	Pre	85.30	1.74	82.39	1.75		
	Post	86.91	1.23	87.34	1.21	.25	n.s.

*For the sake of brevity and readability, the specific t and p values for group comparisons before treatment are not presented since none was significant at the p = .05 level.

**All post-treatment means adjusted for pre-treatment values.

++two-tailed tests

Table 8

Pre-Treatment* and Post-Treatment** Mean Values

on Daniels-Diack Phonetic Reading Tests

Test	Treatment Period	Treatment Group: Reading Remediation Mean	Reading Remediation s.e.	Remediation & Methylphenidate Mean	Remediation & Methylphenidate s.e.	ANCOVA t	ANCOVA p++
Oral Reading Test							
Reading Age (in months)	Pre	84.14	2.46	80.94	2.59		
	Post	95.82	1.41	99.14	1.36	1.69	.09
Reading Quotient	Pre	70.69	1.84	66.25	1.80		
	Post	77.00	1.52	78.93	1.50	.89	n.s.
Word Recognition+							
Phonically Simple (15)	Pre	2.73	.51	2.63	.53		
	Post	.16	.07	.10	.07	.60	n.s.
Consonant Blends Beginning (22)	Pre	9.10	1.00	9.69	1.11		
	Post	2.93	.49	3.23	.48	.45	n.s.
Consonant Blends Ending (16)	Pre	5.50	.69	6.03	.76		
	Post	1.83	.26	1.55	.25	.66	n.s.
Polysyllabic-Phonically Simple (15)	Pre	7.70	.79	8.50	.73		
	Post	4.55	.41	3.34	.40	2.11	.04
Graded Phonically Complex (52)	Pre	19.87	2.32	22.97	2.57		
	Post	12.02	.10	9.40	.98	1.87	.06
Common Words (20)	Pre	4.03	.71	4.13	.69		
	Post	1.69	.25	1.40	.29	.81	n.s.
Reversible Words (12)	Pre	5.33	.63	5.31	.60		
	Post	1.91	.26	1.64	.26	.73	n.s.
Nonsense Syllables (12)	Pre	8.63	.54	8.38	.57		
	Post	2.35	.33	2.33	.33	.01	n.s.

* For the sake of brevity and readability, the specific t and p values for group comparisons before treatment are not presented since none was significant at the p =.05 level.

** All post-treatment means adjusted for pre-treatment values.

+ Number of errors

++ two-tailed tests

() parentheses indicate maximum score possible.

Table 9

Pre-Treatment* and Post-Treatment** Mean Grade Levels

On the Stanford Achievement Reading Tests

Subtest	Treatment Period	Treatment Group: Reading Remediation (N = 27-30)x Mean	s.e.	Treatment Group: Remediation & Methylphenidate (N = 27-32)x Mean	s.e.	ANCOVA t	p++
Vocabulary	Pre	3.54	.20	3.73	.31		
	Post	4.16	.15	4.78	.15	.17	n.s.
Reading Comprehension	Pre	2.94	.21	2.89	.24		
	Post	3.86	.18	4.19	.18	1.32	n.s.
Spelling	Pre	3.15	.27	2.95	.26		
	Post	3.67	.19	3.63	.18	.17	n.s.
Word Study Skills	Pre	2.77	.23	2.72	.16		
	Post	3.83	.19	3.94	.20	.39	n.s.
Language	Pre	2.89	.31	2.39	.33		
	Post	3.62	.20	4.32	.20	2.38	.02

* For the sake of brevity and readability, the specific t and p values for group comparisons before treatment are not presented since none was significant at the p = .05 level.

** All post-treatment means adjusted for pre-treatment values.

++ two-tailed tests

x all tests were not available at all levels.

Table 10

Pre-Treatment* and Post-Treatment** Mean Values

on Academic Tests Other Than Reading

Test	Treatment Period	Treatment Group: Reading Remediation (N = 26-30)+ Mean	s.e.	Treatment Group: Remediation & Methylphenidate (N = 27-31)+ Mean	s.e.	ANCOVA t	p++
WRAT (Standard Scores)							
Arithmetic	Pre	91.63	1.70	88.52	1.85		
	Post	87.40	1.86	91.63	1.83	1.51	n.s.
Spelling	Pre	84.50	1.74	81.35	2.01		
	Post	84.64	1.19	85.92	1.17	.76	n.s.
Stanford Achievement (Grade Levels)							
Math Computation	Pre	4.06	.30	3.85	.27		
	Post	4.65	.17	5.15	.16	2.12	.04
Math Concepts	Pre	3.44	.20	3.86	.26		
	Post	4.58	.17	4.61	.16	.37	n.s.
Math Application	Pre	3.52	.26	4.04	.31		
	Post	4.45	.17	5.17	.17	2.96	.005
Social Studies	Pre	3.31	.25	3.62	.26		
	Post	4.16	.15	4.78	.15	2.93	.005
Science	Pre	3.07	.22	3.45	.25		
	Post	3.91	.22	4.38	.22	1.35	n.s.
Total Math	Pre	3.51	.36	4.31	.31		
	Post	4.72	.14	5.52	.12	4.15	.0003

* For the sake of brevity and readability, the specific t and p values for group comparisc before treatment are not presented since none was significant at the p = .05 level.

** All post-treatment means adjusted for pre-treatment values.

+ All tests were not available at all levels

++ two-tailed tests

Table 11

Pre-Treatment* and Post-Treatment** Mean Values

on WISC-R IQ Test

IQ	Treatment Period	Treatment Group: Reading Remediation (N = 30) Mean	s.e.	Remediation & Methylphenidate (N = 32) Mean	s.e.	ANCOVA t	p++
VIQ	Pre	95.37	1.32	98.10	1.79		
	Post	98.16	.92	100.07	.91	1.47	n.s.
PIQ	Pre	97.63	1.70	99.29	2.04		
	Post	107.58	1.64	113.08	1.61	2.39	.02
FISQ	Pre	96.03	1.39	98.42	1.70		
	Post	101.73	1.05	106.45	1.03	2.51	.02

* For the sake of brevity and readability, the specific t and p values for group comparisons before treatment are not presented since none was significant at the p = .05 level.

** All post-treatment means adjusted for pre-treatment values.

++ two-tailed tests

Table 12

Pre-Treatment* and Post-Treatment** Mean Values

on Psychological Tests

Test	Treatment Period	Treatment Group: Reading Remediation Mean	Reading Remediation s.e.	Remediation & Methylphenidate Mean	Remediation & Methylphenidate s.e.	ANCOVA t	ANCOVA p++
Continuous Performance Task							
Errors of Commission	Pre	7.69	1.94	3.39	.82		
	Post	3.74	.81	1.28	.78	2.16	.04
Errors of Omission	Pre	2.81	.62	2.18	.44		
	Post	1.73	.34	.93	.33	1.69	.10
Paired Associate (# of Trials)	Pre	7.57	.60	6.28	.54		
	Post	4.91	.30	4.58	.30	.77	n.s.
Visual Sequential Memory Test	Pre	99.77	3.86	103.19	4.26		
	Post	107.92	3.40	118.31	3.40	2.16	.04
Children's Embedded Figures Test	Pre	10.93	1.22	11.94	.96		
	Post	12.93	.95	13.72	.89	.60	n.s.
Raven's Matrices (percentile)	Pre	25.64	4.80	38.75	6.73		
	Post	39.23	5.28	56.78	4.87	2.42	.02
Matching Familiar Figures							
Latency	Pre	11.97	.86	12.58	.87		
	Post	12.45	1.08	15.11	1.06	2.42	.02
Total Errors	Pre	12.27	1.14	12.19	1.14		
	Post	1.96	.07	1.79	.07	1.63	n.s.
Purdue Peg Board							
Right Hand	Pre	38.07	.85	41.41	1.01		
	Post	43.08	.65	43.49	.61	.45	n.s.
Left Hand	Pre	37.32	.87	39.78	1.01		
	Post	39.96	.72	41.82	.68	1.87	.07
Both Hands	Pre	31.04	.80	32.75	1.12		
	Post	34.58	.98	35.35	.93	.57	n.s.
Left, Right, & Both Hands	Pre	106.43	2.25	113.94	2.95		
	Post	117.99	1.68	120.55	1.58	1.10	n.s.
Assembly	Pre	75.59	3.08	83.47	4.21		
	Post	87.58	2.51	93.70	2.36	1.77	.08

(Table 12 continued)

Porteus Mazes							
IQ	Pre	112.47	2.98	114.71	3.10		
	Post	116.79	2.28	126.11	2.24	2.92	.005
Qualitative Score	Pre	50.00	3.75	49.65	3.04		
	Post	56.13	3.68	54.71	3.62	.28	n.s.
Visual Motor Integration+	Pre	92.60	3.94	94.74	4.64		
	Post	94.22	3.40	99.98	3.35	1.21	n.s.
Draw A Person IQ	Pre	105.30	4.19	103.78	4.48		
	Post	104.75	2.72	104.84	2.67	.02	n.s.

* For the sake of brevity and readability, the specific t and p values for group comparisons before treatment are not presented since none was significant at the p= .05 level.

** All post-treatment means adjusted for pre-treatment values.

+ Mental Age (score corrected for chronological age).

++ two-tailed tests

Table 13

Mean Values at Two and Eight Months Follow-up

On Pollack Auditory Test

Subtest	Follow-up Period	Treatment Group: Reading Remediation Mean	Reading Remediation s.e.	Remediation & Methylphenidate Mean	Remediation & Methylphenidate s.e.	ANCOVA t	ANCOVA p++
Phoneme Discrimination (% correct)	2 Months	98.87	.57	99.54	.56	.84	n.s.
	8 Months	98.83	.61	99.28	.57	.55	n.s.
Blend Score (% correct)	2 Months	94.24	2.53	93.73	2.46	.14	n.s.
	8 Months	93.92	2.45	91.54	2.30	.71	n.s.

++ two-tailed tests

Table 14

Mean Values at Two and Eight Months Follow-up
on Roswell-Chall Auditory Blending and
Diagnostic Reading Tests

	Follow-up Period	Treatment Group: Reading Remediation Mean	s.e.	Remediation & Methylphenidate Mean	s.e.	ANCOVA t	p ++
Auditory Blending x	2 Months	29.53	.23	29.49	.22	.13	n.s.
	8 Months	29.15	.24	29.20	.22	.16	n.s.
Diagnostic Reading +							
Single Consonant Sounds	2 Months	.88	.23	.86	.23	.05	n.s.
	8 Months	.72	.18	.95	.16	.99	n.s.
Consonant Combination	2 Months	1.64	.36	1.29	.35	.70	n.s.
	8 Months	1.37	.30	1.25	.27	.31	n.s.
Short Vowels	2 Months	2.01	.72	2.49	.69	.48	n.s.
	8 Months	2.20	.60	2.76	.56	.68	n.s.
Rule of Silent E	2 Months	1.00	.33	1.29	.32	.62	n.s.
	8 Months	1.34	.33	1.44	.30	.23	n.s.
Vowel Combination	2 Months	3.39	.43	4.40	.42	1.68	n.s.
	8 Months	3.17	.44	2.86	.41	.52	n.s.
Syllabification	2 Months	5.48	.28	5.44	.27	.10	n.s.
	8 Months	5.07	.36	4.91	.33	.33	n.s.

x Number correct

+ Number of errors

++ two-tailed tests

Table 16

Mean Values at Two and Eight Months Follow-up

on Daniels-Diack Phonetic Reading Tests

Test	Follow-up Period	Treatment Group: Reading Remediation Mean	Reading Remediation s.e.	Remediation & Methylphenidate Mean	Remediation & Methylphenidate s.e.	ANCOVA t	ANCOVA p++
Oral Reading Test							
Reading Age (in months)	2 Months	95.02	1.49	97.11	1.39	1.02	n.s.
	8 Months	98.75	1.28	98.94	1.19	.25	n.s.
Reading Quotient	2 Months	75.05	1.49	75.73	1.38	.33	n.s.
	8 Months	73.06	1.66	75.46	1.50	1.24	n.s.
Word Recognition+							
Phonically Simple	2 Months	.43	.15	.64	.14	1.03	n.s.
	8 Months	.47	.30	.94	.28	1.15	n.s.
Consonant Blends Beginning	2 Months	4.06	.60	4.01	.57	.01	n.s.
	8 Months	3.30	.56	3.74	.52	.58	n.s.
Consonant Blends Ending	2 Months	2.75	.60	2.51	.57	.45	n.s.
	8 Months	2.19	.45	2.22	.42	.00	n.s.
Polysyllabic-Phonically Simple	2 Months	4.77	.45	3.85	.42	1.48	n.s.
	8 Months	4.45	.40	3.59	.36	1.59	n.s.
Graded Phonically Complex	2 Months	11.90	1.04	11.14	.97	.33	n.s.
	8 Months	9.31	1.02	7.84	.95	1.05	n.s.
Common Words	2 Months	1.69	.28	1.96	.26	.72	n.s.
	8 Months	1.61	.24	1.10	.22	1.55	n.s.
Reversible Words	2 Months	1.98	.27	2.73	.25	2.04	.05
	8 Months	2.01	.31	2.06	.28	.14	n.s.
Nonsense Syllables	2 Months	3.31	.47	4.37	.44	1.64	n.s.
	8 Months	3.77	.51	4.75	.46	1.42	n.s.

+ Number of errors

++ two-tailed tests

Table 15

Mean Values at Two and Eight Months Follow-up

On Gray Oral Reading and Wide Range Achievement Tests

Reading Test	Follow-up Period	Treatment Group				ANCOVA	
		Reading Remediation		Remediation & Methylphenidate			
		Mean	s.e.	Mean	s.e.	t	p++
GOR (Grade Levels)	2 Months	2.53	.16	2.68	.16	.64	n.s.
	8 Months	2.97	.52	3.79	.51	1.12	n.s.
WRAT (Standard Scores)	2 Months	86.52	1.23	85.45	1.23	.61	n.s.
	8 Months	86.95	1.31	88.29	1.36	.63	n.s.

++ two-tailed tests

Table 17

Mean Grade Levels at Two and Eight Months Follow-up

On Stanford Achievement Reading Tests

Subtest	Follow-up Period	Treatment Group: Reading Remediation Mean	Reading Remediation s.e.	Remediation & Methylphenidate Mean	Remediation & Methylphenidate s.e.	ANCOVA t	ANCOVA p++
Vocabulary	2 Months	4.30	.19	4.44	.18	.53	n.s.
	8 Months	4.73	.26	5.09	.25	.99	n.s.
Reading Comprehension	2 Months	3.73	.21	3.60	.20	.42	n.s.
	8 Months	3.76	.22	4.31	.21	1.78	.08
Spelling	2 Months	3.60	.17	3.79	.17	.77	n.s.
	8 Months	3.85	.21	4.02	.19	.58	n.s.
Word Study Skills	2 Months	3.64	.18	3.51	.18	.51	n.s.
	8 Months	3.74	.19	3.53	.18	.79	n.s.
Language	2 Months	3.68	.24	3.53	.23	.45	n.s.
	8 Months	3.96	.28	4.46	.27	1.28	n.s.

++ two-tailed tests

Table 18

Mean Values at Two and Eight Months Follow-up

on Academic Tests Other Than Reading

Test	Follow-up Period	Treatment Group: Reading Remediation Mean	Reading Remediation s.e.	Remediation & Methylphenidate Mean	Remediation & Methylphenidate s.e.	ANCOVA t	ANCOVA p++
WRAT (Standard Scores)							
Arithmetic	2 Months	86.65	2.09	90.38	2.09	1.26	n.s.
	8 Months	84.04	1.75	85.72	1.79	.66	n.s.
Spelling	2 Months	82.88	1.15	82.50	1.15	.24	n.s.
	8 Months	83.59	1.30	83.65	1.36	.00	n.s.
Stanford Achievement (Grade Levels)							
Math Computation	2 Months	4.36	.15	4.47	.15	.48	n.s.
	8 Months	4.73	.25	5.15	.24	1.23	n.s.
Math Concepts	2 Months	4.51	.21	4.26	.19	.85	n.s.
	8 Months	4.86	.23	5.01	.22	.45	n.s.
Math Application	2 Months	4.65	.20	4.84	.19	.69	n.s.
	8 Months	4.52	.26	5.06	.26	1.47	n.s.
Social Studies	2 Months	4.05	.24	4.39	.24	.96	n.s.
	8 Months	4.35	.26	4.79	.25	1.20	n.s.
Science	2 Months	3.93	.23	3.68	.23	.75	n.s.
	8 Months	4.22	.24	4.46	.24	.70	n.s.
Total Math	2 Months	4.64	.16	4.78	.14	.62	n.s.
	8 Months	5.15	.35	5.45	.28	.76	n.s.

++two-tailed tests

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